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North Atlantic Marine Mammals

GORDON T. WARING, DEBRA L. PALKA AND PETER G.H. EVANS

Marine mammals are a diverse, widespread, and significant component of North Atlantic marine ecosystems. Four of the five commonly recognized marine mammal taxa reside in the North Atlantic: cetaceans (mysticetes, baleen whales; and odontocetes, toothed whales, dolphins, and porpoises), sirenians [manatees (*Trichechus* spp.)], pinnipeds, [seals and walruses (*Odobenus rosmarus*)], and polar bears (*Ursus maritimus*) (Rice, 1998; Reeves *et al.*, 2002). A fifth taxon [marine (*Lontra felina*) and sea (*Enhydra lutris*) otters] and sea lions and fur seals (family Otariidae) have not inhabited the North Atlantic since at least the late Pleistocene.

The systematics of marine mammals is still being disputed (Rice, 1998). Marine mammals occupy all North Atlantic marine regimes, tropical to polar, although species-specific ranges exist and distribution patterns are not uniform (Tables I and II). The large-scale, nonrandom distribution of marine mammals is influenced by oceanographic features, whereas small-scale distributions are influenced by factors such as the animal's physiology, behavior, and ecology (Bowen and Siniff, 1999). Over geologic time scales, the diversity and ecology of North Atlantic marine mammals reflect adaptation to a dynamic aquatic environment. As elsewhere, North Atlantic marine mammal populations have been impacted significantly by human interactions (Sahrhage and Lundbek, 1992; Kinze, 1995; Gambell, 1999; Reeves *et al*., 2003). Some species have been, and continue to be, harvested for subsistence and commercial use and for their cultural value. Overexploitation has resulted in extinction [e.g., Caribbean monk seal (*Monachus tropicalis*), Atlantic gray whale (*Eschrichtius robustus*)] and significant population declines [e.g., North Atlantic right whale (*Eubalaena glacialis*)], and has also likely caused significant ecological "changes" (e.g., reduction of top predators and competitive interactions; Rice, 1998; Kraus and Rolland, 2007). Indirect mortality (e.g., fishery bycatch and pollution) has adversely affected numerous species [e.g., harbor porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), beluga whale (*Delphinapterus leucas*), and a ringed seal subspecies (*Phoca hispida botnica*)] (Kinze, 1995; Northridge and Hofman, 1999; O'Shea, 1999; Reijnders *et al*., 1999; Hall and Donovan, 2002; Reeves and Reijnders, 2002). Climate change is also affecting marine mammal populations, especially species that live in close association with the Arctic ice and/or in the cold temperate to polar seas influenced by Arctic ice [e.g., polar bears and Arctic ringed seal (*Phoca hispida hispida*)] (Learmonth *et al*., 2006). p1160 AUQ8

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The physical characteristics of the North Atlantic ecosystem (Fig. 1) critically influence marine mammal distribution. Although the ocean basin provides marine mammals with an open pathway that extends from the equator northward to the Arctic and includes adjacent bodies of water (e.g., Gulf of Mexico, Caribbean Sea, North Sea, Norwegian Sea, and Bay of Biscay), the North Atlantic has many different ecosystems (Reid *et al*., 2003; Stenseth *et al*., 2004). Some adjacent seas, such as the Baltic and Mediterranean, are more isolated from the open ocean and form separate ecosystems. In the p1170 t0020

TABLE I

Occurrence of Marine Mammal Species in the Eastern North Atlantic (including North, Baltic, Barents, and White Seas), by Country

Cetacean Species	*FO*	*IC*	*RUS*	*NO*	*DK*	*SE*	*FI*	*EBA*	*Country* *PO*	*DE*	*NL*	*BE*	*UK*	*IE*	*FR*	*ES*	*PT*	*MAC*	*WAFR*
(a) Baleen whales and large toothed whales																			
Bowhead whale	–	VAG	RAR	RAR[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
N. Atlantic right whale	VAG	–	–	VAG	–°	–	–	–	–	–	VAG	–°	VAG	VAG	–°	VAG	VAG	VAG	VAG
Minke whale	COM	COM	COM	COM	COM[b]	RAR	–	–	–	RAR	RAR	VAG	COM[c]	REG[d]	REG	REG	COM	RAR	RAR
Sei whale	RAR	REG	RAR	RAR	VAG	RAR	–	–	–	VAG	VAG	VAG	RAR	REG	RAR	RAR	REG	RAR	RAR
Bryde's whale	–	–	–	–	VAG	–	–	–	–	–	–	–	–	–	–	–	–	REG	REG
Blue whale	RAR	REG	RAR	RAR	–°	–	–	–	–	–	–°	–°	RAR	RAR	VAG	RAR	VAG	RAR	RAR
Fin whale	REG	REG	REG	REG	VAG	RAR	–	–	–	VAG	VAG	VAG	REG	REG	RAR	REG	REG	REG	REG
Humpback whale	REG	REG	RAR	COM	VAG	VAG	–°	–	–°	VAG	VAG	–°	RAR	RAR	VAG	RAR	RAR	RAR	REG
Atlantic gray whaleu	–	–	–	–	–	EXT	–	–	–	–	EXT	EXT	EXT	–	–	–	–	–	–
Sperm whale	REG	REG	REG	REG	RAR	RAR	–	–	VAG	VAG	VAG	VAG	RAR	RAR	REG	REG	REG	REG	REG
(b) Small cetaceans																			
Pygmy sperm whale	–	–	–	–	–	–	–	–	–	–	–°	–	VAG	VAG	RAR	VAG	VAG	RAR	RAR
Dwarf sperm whale	–	–	–	–	–	–	–	–	–	–	–	–	–	–	VAG	VAG	–	VAG	RAR
N. bottlenose whale	REG	REG	REG	REG	VAG	RAR	–	–	–°	VAG	VAG	–°	REG	REG	RAR	REG	–	RAR	VAG
Sowerby's beaked whale	RAR	RAR	–	RAR	VAG	RAR	–	–	–	VAG	VAG	–°	RAR	RAR	RAR	RAR	RAR	RAR[l]	VAG
Blainville's beaked whale	–	–	–	–	–	–	–	–	–	–	VAG	–	VAG	–	VAG	VAG	VAG	REG	REG
Gervais' beaked whale	–	VAG	–	–	–	–	–	–	–	–	–	–	–	VAG	VAG	–	RAR	VAG[m]	VAG
Gray's beaked whale	–	–	–	–	–	–	–	–	–	–°	–	–	–	–°	–	–	–	–	–
True's beaked whale	–	–	–	–	–	–	–	–	–	–	–	–°	–	VAG	VAG	VAG	–	VAG	VAG
Cuvier's beaked whale	–	–	–	–	–	RAR	–	–	–	–	VAG	VAG	RAR	RAR	REG	REG	RAR	REG	REG
Beluga	VAG	RAR	COM	RAR	VAG[e]	RAR	–	–	–°	VAG	VAG	VAG	VAG	–	–	–	–	–	–
Narwhal	–°	VAG	RAR[s]	RAR	–	VAG	–	–	–	–	–°	–	–°	–	–	–	–	–	–
Short-bked com. Dolphin	VAG	VAG	–	VAG	REG	RAR	RAR	–	VAG	VAG	RAR	VAG	COM	COM	COM	COM	COM	REG[n]	RAR
Long-bked com. Dolphin	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	COM
Pygmy killer whale	–	–	–	–	–	–	–	–	–	–	–	–	–	–	VAG	VAG	–	VAG	RAR
Short-finned pilot whale	–	–	–	–	–	–	–	–	–	–	–	–	–	–	VAG	VAG	–	COM	COM
Long-finned pilot whale	COM	COM	–	COM[f]	RAR	RAR	–	–	–	VAG	VAG	VAG	COM	COM	COM	COM	COM	–l	–
Risso's dolphin	–	–	–	VAG	–°	RAR	–	–	–	VAG	VAG	RAR	REG	REG	REG	REG	COM	COM	REG
Fraser's dolphin	–	–	–	–	–	–	–	–	–	–	–	–	–	–	VAG	–	VAG	VAG	RAR
Atlantic White-sided dolphin	COM	COM	–	COM	RAR	RAR	–	–	–	VAG	RAR	VAG	COM	COM	RAR	RAR	RAR	–	–
White-beaked dolphin	RAR	COM	–	COM	COMg	RAR	RAR	–	RAR	RAR	REG	RAR	COM	REG	RAR	VAG	–	–	–
Killer whale	COM	REG	REG	REG	REGh	VAG	–	REG	–	VAG	VAG	VAG	REG	REG	RAR	RAR	REG	RAR	RAR
Melon-headed whale	–	–	–	–	–	–	–	–	–	–	–	–°	–°	–	VAG	–	–	VAGq	REG
False killer whale	–°	–	–	VAG	–°	–°	–	–	–	–°	–°	–	VAG	VAG	VAG	VAG	RAR	RAR	REG
Atl. humpback dolphin	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	REG

Pantrop. spotted dolphin	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	RAR	REG
Clymene dolphin	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	RAR
Striped dolphin	VAG	VAG	–	VAG	VAG	VAG	–	–	VAG	VAG	VAG	VAG	RAR	RAR	COM	COM	COM	COM	REG
Atlantic spotted dolphin	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	VAG	–	REG	COM
Spinner dolphin	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	RARr	COM
Rough-toothed dolphin	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	REG	REG
Bottlenose dolphin	REG	–	–	VAG	VAG	VAG	–	–	–	VAG	RAR	VAG	COM	COM	COM	COM	COM	COM	COM
Harbor porpoise	COM	RAR	RARt	COM	COM	COM	RAR	RARt	RAR	COM	COM	COM	COM	COM	COM	COM	COM	VAG	RAR
(c) Pinnipeds																			
Hooded seal	REG	REG	RAR	REGi	–	–	–	RAR	–	–	–	–	VAG	VAG	VAG	VAG	VAG	–	–
Bearded seal	RAR	RAR	RAR	REG	–	–	–	RAR	–	–	–	–	VAG	VAG	VAG	VAG	VAG	–	–
Grey seal	REG	REG	RAR	COM	REG	REG	REG	RAR	REG	RAR	REG	REG	COM	REG	REGj	–	–	–	–
Harp seal	RAR	RAR	COM	REGi	RAR	–	–	COM	–	VAG	–	–	VAG	–	VAG	–	–	–	–
Ringed seal	VAG	RAR	REG	COM	REG	REG	REG	REG	VAG	VAG	–	–	VAG	–	–	–	VAG	–	–
Harbor seal	VAG	COM	REG	COMk	COM	COM	RAR	REG	RAR	COM	COM	REG	COM	REG	RAR	–	–	VAG	–
Mediterr. monk seal	–	–	–	–	–	–	–	–	–	–	–	–	–	VAG	VAG	VAG	RARo	RARp	
Walrus	VAG	VAG	COM	REGi	VAG	RAR	RAR	COM	–	–	VAG	VAG	VAG	VAG	VAG	VAG	–	–	–
(d) Carnivores																			
Polar bear	–	VAG	RAR	REGi	–		–	RAR	–	–	–	–	–	–	–	–	–	–	–

NOTES:Countries: FO, Faroe Islands; IC, Iceland; NO, Norway; DK, Denmark; SE, Sweden; FI, Finland; RUS, Russia (both Barents Sea and Eastern Baltic); EBA, Eastern Baltic States (Latvia, Lithuania, and Estonia); PL, Poland; DE, Germany; NL, Netherlands; BE, Belgium, UK, United Kingdom; IE, Ireland; FR, (Atlantic) France; ES, (Atlantic) Spain (excl. Canaries); PT, (Atlantic) Portugal (excl. Azores & Madeira/Desertas); MAC, Macaronesia (Azores, Madeira/Desertas, Canaries, Cape Verdes); WAFR, West Africa from Morocco to the EquatorOccurrence (based on records since 1980): VAG, Vagrant; RAR, Rare; REG, Regular (but Uncommon); COM, Common; EXT, Extinct; –, Not Recorded; °, Record(s) before 1980.

RAR in northern Norway only.
REG in Kattegat/Baltic.
But REG in Channel and Southern North Sea.
But COM in Southwest.
But annual, periodically.
But periodic, at other times RAR.
REG in Kattegat/Baltic.
RAR in Kattegat/Baltic.
REG only in arctic islands of Svalbard, Bornøya and Jan Mayen.
COM in N. France, rare further south in France.
But REG in parts of Norway; Includes isolated population in Svalbard.
But VAG in Canaries and Cape Verdes.
But RAR in Canaries.
But RAR in Canaries and Cape Verdes.
RAR in Madeira/Desertas and Canaries, VAG in Cape Verdes, absent from Azores.
RAR only in Morocco and Mauritania, VAG further south.
But RAR in Cape Verdes.
RAR in Canaries, but REG in Cape Verdes and absent from Azores and Madeira/Desertas.
Mainly around Frantz-Josef Land.
But VAG in eastern Baltic.
Records only from Belgium, Netherlands, Sweden, and the United Kingdom.

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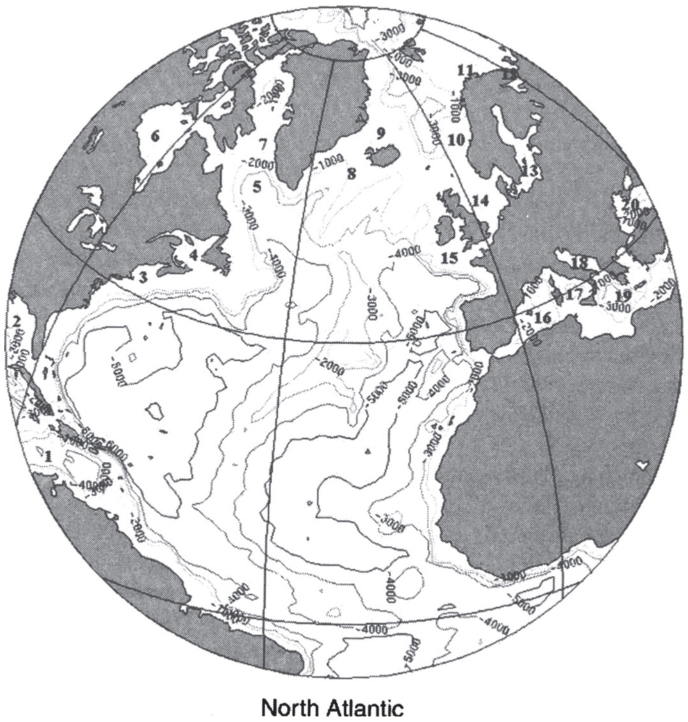
Table II
Occurrence of Marine Mammal Species in the Western North Atlantic (including Greenland), by Region

Cetacean SPECIES	*CAR*	*GOM*	*Region SE-USA*	*NE-USA*	*CA-MA*	*CA-AR*	*GRE*
(a) Baleen whales and large toothed whales							
Bowhead whale	–	–	–	–	–	COM	REG
N. Atlantic right whale	–	VAG	REG	REG	REG	–	–
Minke whale	RAR	RAR	REG	COM	COM	COM	COM
Sei whale	RAR	VAG	RAR	COM	COM	–	REG
Bryde's whale	COM	REG	RAR	RAR	–	–	–
Blue whale	VAG	VAG	VAG	RAR	REG	REG	RAR
Fin whale	COM[a]	COM	RAR	COM	COM	REG	REG[d]
Humpback whale	COM	RAR	COM	COM	COM	COM	COM
Sperm whale	COM	COM	COM	COM	COM	COM	REG
(b) Small cetaceans							
Pygmy sperm whale	RAR	COM	REG	VAG	–	–	–
Dwarf sperm whale	RAR	COM	REG	VAG	–	–	–
N. bottlenose whale	VAG	–	–	RAR	COM	RAR	REG
Sowerby's beaked whale	–	VAG	VAG	REG	RAR	RAR	–
Blainville's beaked whale	REG	REG	REG	RAR	RAR	–	–
Gervais' beaked whale	RAR	REG	REG	VAG	–	–	–
True's beaked whale	–	–	REG	REG	RAR	–	–
Cuvier's beaked whale	REG	COM	REG	RAR	RAR	–	–
Beluga	–	–	–	–	COM	COM	COM
Narwhal	–	–	–	–	–	COM	REG
Short-bked com. Dolphin	–	–	COM	COM	COM	–	–
Long-bked com. Dolphin	REG	–	–	–	–	–	–
Pygmy killer whale	COM	COM	REG	–	–	–	–
Short-finned pilot whale	COM	COM	COM	RAR	–	–	–
Long-finned pilot whale	–	–	REG	COM	COM	–	RAR
Risso's dolphin	REG	COM	COM	COM	COM	–	–
Fraser's dolphin	REG	REG	REG	–	–	–	–
Atl. White-sided dolphin	–	–	–	COM	COM	REG	REG
White-beaked dolphin	–	–	–	REG	COM		COM[e]

Killer whale	REG	REG	RAR	RAR	RAR	REG	REG
Melon-headed whale	REG	COM	REG	–	–	–	–
False killer whale	REG	COM	REG	–	–	–	–
Alt. Hump-backed dolphin	–	–	–	–	–	–	–
Pantropical spotted dolphin	COM	COM	COM	RAR	–	–	–
Clymene dolphin	REG	COM	COM	–	–	–	–
Striped dolphin	COM[b]	COM	COM	COM	REG	–	–
Atlantic spotted dolphin	COM	COM	COM	COM	–	–	–
Spinner dolphin	COM	COM	REG	–	–	–	–
Rough-toothed dolphin	REG	COM	REG	–	–	–	–
Bottlenose dolphin	COM	COM	COM	COM		–	–
Harbor porpoise	–	–	VAG	COM	COM	–	COM
(c) Manatees							
Florida manatee	–	COM	COM	VAG	–	–	–
Antillean manatee	REGc	VAG	–	–	–	–	–
(d) Pinnipeds							
Hooded seal	VAG	–	VAG	REG	COM	COM	COM
Atlantic bearded seal	–	–	–	VAG	VAG	COM	COM
Gray seal	–	–	VAG	COM	COM	–	–
Harp seal	VAG	–	–	REG	COM	COM	COM
Arctic ringed seal	–	–	–	–	–	COM	COM
W. Atlantic harbor seal	–	–	VAG	COM	COM	COM	COM
Mediterranean monk seal							
Caribbean monk seal	EXT	EXT	–	–	–	–	–
Walrus	–	–	–	–	–	COM	COM
Polar bear	–	–	–	–	VAG	COM	REGf

NOTES"Regions: CAR, Caribbean; GOM, Gulf of Mexico; SE-USA, Southeast USA; NE-USA, Northeast USA; CA-MA, Canadian Maritimes; CA-AR, Canadian Arctic; GRE, Greenland.Occurrence: VAG, Vagrant; RAR, Rare; REG, Regular (but Uncommon); COM, Common; EXT, Extinct; –, Not Recorded.
COM in north but RAR further south,
COM in north, REG in south,
absent from Eastern Caribbean,
COM in southeast,
common near the tip of Greenland and they are more common than Atl. White-sided
rare in the areas with people, common on the east Greenland coast and off shore in West Greenland

N



f0120 **Figure 1** *Bodies of water in the North Atlantic. Depth contours in meters. 1, Caribbean Sea; 2, Gulf of Mexico; 3, Gulf of Maine; 4, Gulf of St. Lawrence; 5, Labrador Sea; 6, Hudson Bay; 7, Davis Strait; 8, Denmark Strait; 9, Greenland Sea; 10, Norwegian Sea; 11, Barents Sea; 12, White Sea; 13, Baltic Sea; 14, North Sea; 15, Celtic Sea; 16, Mediterranean Sea; 17, Tyrrhenian Sea; 18, Adriatic Sea; 19, Aegean Sea; 20, Black Sea.*

open ocean, water masses define tropical to polar ecosystems that are influenced by circulation patterns of the major ocean currents such as the Gulf Stream, Greenland current, and North Equatorial current. There are broad continental shelf ecosystems defined by basins, banks, channels, ice, submarine canyons, and volcanic islands. Sea mounts and the mid-Atlantic Ridge also define important ecosystems. These types of oceanographic features influence productivity which concentrate prey and create high-use marine mammal habitats (Reid *et al*., 2003).

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II. Distribution and Habits

p1180 AUQ9 Baleen whales are widely distributed in the North Atlantic, with individual species exhibiting preferences for certain ecosystems (Jefferson *et al*., 1993; Bowen and Siniff, 1999). Some preferences are temperature driven. For example, bowhead whales (*Balaena mysticetus*) occupy only polar waters, whereas Bryde's whales (*Balaenoptera edeni*) are found only in tropical waters. Other preferences are more topography driven. For example, right, humpback (*Megaptera novaeangliae*), and minke (*Balaenoptera acutorostrata*) whales prefer continental shelf ecosystems, whereas blue (*B. musculus*), sei (*B. borealis*), and Bryde's whales are associated with shelf-edge and deeper oceanic water. While fin whale (*Balaenoptera physalus*) habitat preference differs geographically (i.e., shelf ecosystems in the northwest Atlantic and shelf-edge habitats off NW Europe). Large whales, however, are highly mobile and seasonally may occupy different habitats. Baleen whales, except bowhead and Bryde's whales, can undergo the most extensive seasonal migrations of all North Atlantic marine mammals, migrating between warm low-latitude breeding grounds in winter and cold high-latitude feeding grounds in summer. North Atlantic humpback whales exemplify this migratory behavior (Bowen and Siniff, 1999). In summer, humpback whale stocks feed in Iceland, Greenland, Newfoundland, Gulf of St. Lawrence, and Gulf of Maine/Scotian Shelf and then spend winter on breeding grounds in the Caribbean Sea. A smaller eastern North Atlantic population summers between the Bay of Biscay and the Norway, and spends the winter between the British Isles and the Cape Verdes. Molecular genetic studies indicate that the feeding stocks are matrilineal groups of related individuals (Baker and Palumbi, 1997). There is little evidence of recent genetic exchange between North Atlantic and South Atlantic populations of baleen whales, due largely to seasonal differences in the migration paths of the two populations (Baker and Palumbi, 1997).

p1190 Odontocetes also occupy nearly all marine ecosystems in the North Atlantic, with individual species exhibiting preferences for particular ecosystems (Bowen and Siniff, 1999; Reeves *et al*., 2002; Reid *et al*., 2003; Macleod *et al*., 2006). Continental shelf species found in cool temperate to subpolar waters are harbor porpoises, Atlantic white-sided and white-beaked dolphins (*Lagenorhynchus acutus* and *L. albirostris*), long-finned pilot whales (*Globicephala melas*), and two Arctic species, narwhal (*Monodon monoceros*) and beluga whales. Continental shelf break/pelagic species found in temperate to cooler waters include bottlenose (offshore and coastal forms), short-beaked common (*Delphinus delphis*), Risso's (*Grampus griseus*), striped (*Stenella coeruleoalba*), and Atlantic spotted (*S. frontalis*; coastal form) dolphins, sperm (*Physeter macrocephalus*) and northern bottlenose (*Hyperoodon ampullatus*) whales, and Cuvier's (*Ziphius cavirostris*), Blainville's (*Mesoplodon densirostris*), Sowerby's (*M. bidens*), and True's (*M. mirus*) beaked whales. The range of northern bottlenose and Sowerby's beaked whales extends into subarctic waters. Continental shelf break/pelagic species found in warm temperate to tropical waters are pantropical spotted (*Stenella attenuata*), Atlantic spotted (offshore form), spinner (*S. longirostris*), Clymene (*S. clymene*), rough-toothed (*Steno bredanensis*), Atlantic humpbacked (*Sousa teuszii*), and Fraser's (*Lagenodelphis hosei*) dolphins and melon-headed (*Peponocephala electra*), false killer (*Pseudorca crassidens*), pygmy killer (*Feresa attenuata*), short-finned pilot (*Globicephala macrorhynchus*), pygmy sperm (*Kogia breviceps*), dwarf sperm (*K. sima*), and Grevais' beaked (*Mesoplodon europaeus*) whales. Within warm temperate to tropical water mass habitats, bottom topography and frontal boundaries are important characteristics that define cetacean distribution. Unlike baleen whales, only a few odontocetes (e.g., sperm and long-finned pilot whales) are known to undergo long-range seasonal migrations (Bowen and Siniff, 1999). Stock structure is largely unknown, except for a few nearshore continental shelf species (e.g., harbor porpoise, beluga). Some oceanic odontocetes likely move between North and South Atlantic waters (e.g., pantropical spotted dolphin and Cuvier's beaked whale).

p1200 North Atlantic seals (phocids) include both Northern and Southern Hemisphere species (Tables I and II; Reeves *et al*., 2002). Northern phocids [harbor (*Phoca vitulina*), and gray seals (*Halichoerus grypus*)] are widely distributed in boreal to polar waters (Bowen and Siniff, 1999). The ice seals [hooded (*Cystophora cristata*), bearded (*Erignathus barbatus*), harp (*Pagophilus groenlandicus*), and ringed (*Pusa hispida*) seals] pup on ice and have seasonal migrations that are strongly associated with seasonal ice fluctuations. Bearded, hooded, and harp seals also utilize pelagic habitats. Ranges change; for example, since the 1990s, the winter/spring distributions of hooded and harp seals extended southward into northeast US.coastal waters. Harbor seals are the most widely distributed species, occupying cool temperate to Arctic North Atlantic waters. Gray seals have a discontinuous distribution in cold temperate to subarctic coastal waters. Southern phocids include the Mediterranean (*Monachus monachus*) and Caribbean (extinct) monk seals. The Mediterranean monk seal is primarily found in the Mediterranean, adjacent seas, and along northwestern Africa. The Caribbean monk seal previously inhabited the Caribbean Sea and southern portion of the Gulf of Mexico. Stock structure for North Atlantic seals is well defined.

Cetaceans and phocid seals constitute the largest component of North Atlantic marine mammal fauna (Bowen and Siniff, 1999; Reeves *et al*., 2002). Additional species include walruses, polar bears, and West Indian manatees (*Trichechus manatus*). Walruses and polar bears have a circumpolar distribution. Both species are usually associated with ice habitats but also spend time on coastal land areas. The Florida (*Trichechus manatus latirostris*) and Antillean (*T. m. manatus*) manatees have a tropical to subtropical distribution. The p1240 Florida manatee is found in coastal waters of the Gulf of Mexico and southeastern United States. Seasonal extralimital movements northward have been recorded for the Florida manatee. The Antillean manatee is distributed from northern Mexico to central Brazil and throughout the islands of the Caribbean.

III. Feeding

The taxonomic division of cetaceans into Odontoceti and Mysticeti reflects their different feeding strategies (Rice, 1998; Bowen and Siniff, 1999; Reeves *et al*., 2002). Baleen whales are strainers who largely feed on planktonic or micronektonic crustaceans and/or relatively small pelagic fish by using visual or passive acoustic techniques. Toothed whales are graspers who capture fish, squid, and other species by hunting using sight, sound, or active echolocation. Pinnipeds and polar bears are carnivores. Pinnipeds consume primarily fish and invertebrates, and some species occasionally eat seabirds, seals, or small whales. Polar bears prey primarily on seals and sometimes feed on fish and other small mammals. In contrast, manatees are herbivores, grazing in shallow waters on vegetation using primarily their sense of touch.

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IV. Human Impact

Centuries of human activities have affected all North Atlantic marine mammal populations. Prehistoric people hunted coastal marine mammals for subsistence use, and in some areas (e.g., Canada, Greenland) aboriginal hunting still exists (Sahrhage and Lundbek, 1992; Kinze, 1995; Gambell, 1999; Heide-Jørgensen and Wiig, 2002; Kraus and Rolland, 2007). Early subsistence hunting, however, was likely insignificant compared to commercial whaling that began in Europe during the tenth century (Slijper, 1979; Sahrhage and Lundbek, 1992). By the beginning of the eighteenth century, European whalers had already depleted bowhead and right (*Eubalaena* spp.) whale stocks in the eastern North Atlantic, so then moved on to hunt these species in the western North Atlantic, from Greenland to the Gulf of St. Lawrence. American whalers also depleted right and humpback whale stocks in coastal waters off the American colonies. Depletion of these stocks initiated pelagic whaling for sperm and humpback whales. Modern whaling, as we know it today, began in the late nineteenth century when Norwegians invented the explosive harpoon and converted from sail to steam vessels. This allowed whaling to expand to the faster swimming blue, fin, and sei whales. By the 1920s, the stocks of North Atlantic large whales had all been over-exploited, and so whaling activities were redirected into Antarctic waters. Commercial whaling depleted most of these stocks as well. In 1946 the International Convention for the Regulation of Whaling was signed to provide for the CONSERVATION of whale stocks (Gambell, 1999). However, North Atlantic whaling continued until the 1987 INTERNATIONAL WHALING COMMISSION moratorium was enacted. Following the moratorium, fin and minke whales were still taken for subsistence in West Greenland, and Norway continued a small minke whale fishery as scientific whaling. Recently, Norwegian minke whaling has increased and Iceland p1210 reinitiated commercial hunting for minke and fin whales. Despite the many years since whaling of most species has stopped, some of the North Atlantic large whales (in particular the North Atlantic right whale) have not yet recovered (Clapham *et al*., 1999; Kraus and Rolland, 2007). This is probably due to slow growth, low reproductive rates, and other human interactions (Boyd *et al*., 1999; Evans and Stirling, 2002).

Commercial exploitation of smaller cetaceans began in the fourteenth century when the Danes initiated organized hunts of Baltic Sea harbor porpoises (Kinze, 1995). Although these hunts ended in the mid-twentieth century, there are still very few harbor porpoises in the Baltic Sea. In the 1500s, the Faroese initiated a pilot whale (*Globicephala* spp.) drive fishery that continues to this day. Examples of hunts during the early to mid-1900s include Norwegian hunts of minke, killer (*Orcinus orca*), northern bottlenose, and pilot whales, s0270 American bounty hunts on harbor porpoises, and pilot whale drives p1220 in Shetland, Orkney, and Newfoundland. The Newfoundland fishery continued through the twentieth century but had to stop in 1971 due to local depletion (Mercer, 1975). In the Atlantic islands of the Azores and Madeira, subsistence hunting of sperm whales continued until as recently as the 1980s. Small-cetacean hunts occurring today are small-scale subsistence fisheries, such as for harbor porpoises in Greenland and belugas in Canada, Greenland, and Russia. It is unknown whether these stocks can sustain these removals. Now, even in the traditional whaling countries, whale and dolphin watching has largely replaced whaling as an economic activity (in the Canary Islands currently estimated to involve more than 1 million tourists a year; Urquiola and de Stephanis, 2000)

North Atlantic walrus populations were similarly exploited (Sahrhage and Lundbek, 1992). In the early 1600s, Britain initiated walrus hunting around Spitzbergen, Jan Mayen, and Norway. Russians, s0280 Europeans, and Canadians joined in to expand the hunts further north- p1230 ward. As a result, these walrus populations were severely depleted by the nineteenth century and have not yet recovered.

Seals were first commercially hunted for oil and blubber in Europe p1260 and Newfoundland (Sahrhage and Lundbek, 1992). In these areas, large-scale commercial hunts for seal skins started in the early eighteenth century, focusing on harp and hooded seals, although bearded, ring, gray, and harbor seals were also taken. By the late 1800s, hunting expanded to Greenland for harp, hooded, and ringed seals. During the World Wars, hunting slowed down, allowing some populations to recover. However, sealing resumed immediately afterwards. During the 1960s, killing methods raised public opinion against sealing, which then prompted management actions and quotas to reduce hunting. The largest reduction began in 1983, particularly in Canadian waters, when the European community enacted a ban on the importation of seal skins. However, since 1996, the level of Canadian harp sealing has resumed to pre-1970s levels because new markets for skins and meat have opened up (DFO, 2003).

Long-standing conflicts between humans and seals have occurred p1270 because seals impact economically valuable fishery resources. Impacts include seals preying on fish species, and seals, particularly

s0290 gray and harbor seals, infecting many North Atlantic fish species
p1300 with seal (or cod) worm (*Pseudoterranova decipiens*). These issues have initiated seal bounty programs in Europe and North America, which resulted in regional extirpation (e.g., northeast United States, Baltic Sea), of some gray and harbor seal stocks. Although bounty and other seal removal programs have either ended or been greatly reduced, ecological and fishing gear interactions between seals and fisheries remain a management challenge in the North Atlantic.

Following World War II, technological improvements in fishing gear and vessels led not only to the expansion of coastal and high seas fisheries, but also to the incidental mortality of thousands of marine mammals and rapid depletion of fish resources (Northridge and Hofman, 1999; Hall and Donovan, 2002). By the 1970s, the elevated levels of marine mammal takes, particularly dolphins in the eastern tropical Pacific tuna purse seine fishery, instigated management and conservation measures that were aimed at reducing incidental takes of marine mammals in fisheries (e.g., US Marine Mammal Protection Act of 1972). Over the past two decades, national and international measures have aimed to improve fish stocks and to monitor
s0300 and reduce fishery-related impacts on marine mammals [e.g., 1991 Agreement on the Conservation of Small Cetaceans of the Baltic and
p1310 North Sea (ASCOBANS)]. Unfortunately, marine mammal mortality still occurring in many fisheries threatens some marine mammal populations in the North Atlantic, such as right whales, bottlenose and common dolphins (*Delphinus* spp.), harbor porpoises, and Mediterranean monk seals.

Environmental contaminants potentially pose a threat to the health of marine mammals (O'Shea, 1999; Reijnders *et al*., 1999; Geraci and Lounsbury, 2002). Contaminant levels can become toxic in marine mammals because most feed at high trophic levels and so accumulate low levels of toxins from their contaminated prey. Numerous studies have documented the presence of organochlorine and heavy metals in tissues of marine mammals. The debate is: are these levels dangerous? Potential deleterious biological effects of these contaminants include immunosuppression, endocrine disruption, and reproductive and pathological disorders. Documented cases of deleterious effects include the reproductive failure that has been linked to organochlorine levels in seals from the Baltic and Wadden Seas and to beluga whales from the St. Lawrence Estuary. It has been suggested that some of the large-scale die-off events that have killed thousands of seals and dolphins in northern Europe, the Mediterranean, the US east coast, and Gulf of Mexico are due, at least in part, to high levels of organochlorines (e.g., PCBs; Domingo *et al*., 2002) or toxic metals (e.g., cadmium, mercury; O'Shea, 1999). Epizootic events and toxic algal blooms have also caused large-scale die-offs (Geraci and Lounsbury, 2002; Härkönen *et al*., 2006). For example, both the 1988 and the 2002 *Phocine distemper virus* epidemics in Europe killed approximately 56% and 45%, respectively of the European harbor seal populations. In winter 1987/1988, 14 humpback whales died in the vicinity of Cape Cod after consuming Atlantic mackerel (*Scomber scombrus*) containing a dinoflagellate saxitoxin. However, in nearly all cases, it has not been possible to demonstrate a direct link between death and contaminants. Other types of potentially dangerous environmental contaminants include oil spills and acoustic disturbances because these may cause behavioral modifications, prey displacement, or direct mortality. For example, several unusual mass strandings of beaked whales in North Atlantic marine environments (e.g., Bahamas, Canaries, Madeira) have been associated with military sonar activities (Evans and Miller, 2004; Cox *et al*., 2006).

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V Status

The current status of North Atlantic marine mammal populations is tightly linked to the population's biological characteristics and their long history of interacting with human activities. Most populations are no longer commercially hunted, but some are still severely depleted (e.g., North Atlantic right whales; Gambell, 1999; Kraus and Rolland, 2007). Human activities, such as hunting incidental fishing mortality, acoustic activities, vessel strikes, environmental contaminants and climate change continue to directly and indirectly adversely impact marine mammals. Further, human enhanced cli- p1280
mate warming is predicted to be detrimental to most marine mammal populations, particularly species associated with Arctic ice (Learmonth *et al*., 2006). Conservation and research programs, particularly for small cetaceans, are highly variable among countries. Because most marine mammal populations are mobile, the only way to assess the status of and conserve these populations is to ensure that scientific research and conservation programs are effective ocean wide.

See Also the Following Articles

Cetacea Overview ■ Distribution ■ Fishing Industry ■ Effects of Hunting of Marine Mammals ■ Pinnipedia Overview

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I. North Pacific Marine and Fresh Water Biomes s0310

The vastness and diversity of the North Pacific Ocean is p1320 reflected in the richness of its marine mammal community. Sixteen of the world's 36 species of pinnipeds, 50 of the more than 80 species of cetaceans, and two of the 5 species of sirenians have been reported to occur in the North Pacific, in addition to the polar bear (*Ursus maritimus*) and the sea otter (*Enhydra lutris*). Most of these species are also found in other parts of the world, as is the case of most balenids and delphinids, many ziphiids, and some otariids, phocids, and phocenids. However, a large proportion of the species found in the North Pacific are endemic to its marine or riverine ecosystems: nine pinnipeds, eleven cetaceans, one sirenian, and the sea otter.

The North Pacific Ocean ranges from about 80°W to 130°E, covering almost 60% of the earth's circumference, and from the Arctic Ocean to the Equator (Fig. 1). The North Pacific encompasses a great number of peripheral basins, as different as the highly evaporative and relatively small Gulf of California (also known as Sea of Cortés) in the east, the large and epicontinental Bering Sea in the north, or the complex region of small, semi-enclosed seas and shallow shelves around the Indo-Pacific Archipelago in the west, where the Pacific and the Indian oceans meet. In addition, there exist a number of large, complex river systems that extend thousands of kilometers upstream, as is the case of the Yangtze River in China.

The geographic distribution of mammal species in the ocean depends on a number of factors, among which temperature, depth, and productivity tend to be the most important. Rice (1998) presents a comprehensive review of the ranges for most species. Some, such as the killer whale (*Orcinus orca*) or the sperm whale (*Physeter macrocephalus*), are considered cosmopolitan. Others, like the vaquita (*Phocoena sinus*), or the now extinct Steller's sea cow (*Hydrodamalis gigas*), have very limited ranges. Many species are circumglobal, but limited to particular climatic zones. For example, some species are pantropical, inhabiting low latitude waters in all the world oceans, whereas others have antitropical (or bipolar) distributions. Species such as the ringed seal (*Pusa hispida*) and polar bear have been sighted as far north as the North Pole. Others can range hundreds of kilometers up the great rivers of both sides of the Pacific Ocean, either permanently or on a seasonal basis.

The North Pacific is dominated by a large subtropical gyre (Fig. 1). p1350 This North Pacific central gyre flows clockwise, bounded to the west by the Kuroshio Current, to the north by the North Pacific Current, to the east by the California Current, and along the south by the North Equatorial Current. To the north of the North Pacific central gyre, the cold Oyashio Current flows along the Kamchatka Peninsula and forms the western boundary of a counterclockwise subarctic gyre. The Alaska Current flows counterclockwise along the southeastern coast of Alaska and the Aleutian Peninsula. The convergence zone of these subarctic gyres and the central gyre, known as the Subarctic Boundary, crosses the western and central North Pacific at about 42°N, and marks the steepest change in the abundance of cold-water vs warm-water species. To the south of the central gyre, the equatorial current system